

C++

Const

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Const

- The keyword **const** has different semantics in C++ depending on its context
- **const** in variable declarations means that the value of the variable can not be changed:
const float PI = 3.14156; // PI is a constant
- In C, **#define** was used to define constant. **Do not do that in C++.**
- Using **const** for declaring constant variables provides additional safety (type checking)
- Trying to change a const object results in compile time error.

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Example

```
#include <iostream>

const float PI = 3.14156;
const int i; // compile time error: const must be initialized

int main() {
    std::cout << "Pi is: " << PI << std::endl;
    PI = 3.25; // trying to redefine PI <- compile time error
}
```

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Example 2

```
class Date {
public:
    Date(int m, int d, int y) {
        month=m; day=d; year=y;
    }
    void inc_day() {day++;}
    int process (const Date& d) {
        // d is const and can not be modified
        // in process()
    }
private:
    int month, day, year;
};
```

```
int main () {
    const Date d1(1, 15, 2010);
    d1.inc_day(); // compile-time error

    Date d2(1, 16, 2010);
    int temp = d1.process(d2); // ok
}
```

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Pointer to a const

- “const int* pi” is a **pointer to a const**
 - pi can either be a const or not
 - pi can be changed
 - *pi cannot be changed (it cannot be used in an assignment)

```
const int i = 1; int j = 2;
const int* pi;
pi = &i; pi = &j; // ok
pi = &i; *pi = 3; // compile-time error
pi = &j; *pi = 4; // compile-time error
int* pi2; pi2 = &i; // compile-time error
pi2 = &j; *pi2 = 5; // ok
```

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Const pointer

- It is also possible to have a pointer that is constant (we cannot change the address it points to). This implies nothing about the object being pointed to

```
int a = 5;
int* const pa = &a; // const pointer so must be
                    // assigned at initialization
*pa = 10;           // ok now *pa and a are 5
int b = 2;
pa = &b;           // compile-time error: pa is a
                    // constant
```

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Const pointer to a constant

- Both the pointer and object pointed to are constant.

```
const int a = 1;
const int* const pa = &a;
*pa = 2; // compile-time error
int b = 2; pa = &b; // compile-time error
```
- Note: a const pointer to a const can still point to a non const but it can not change it:

```
int a = 1;
const int* const pa = &a; // ok
*pa = 2; // compile-time error
```

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Const and pointer: summary

- We saw three cases:
 1. const int* pa; // a pointer to a constant
 2. int* const pa = &a; // a const pointer to an int
 3. const int* const pa = &a; // a const pointer to a constant int
- Three important points:
 1. Read the declarations from right to left to figure what is constant
 2. A constant object can not be changed
 3. If p is a pointer to a const then *p can not be assigned to

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References to const

- Similar to pointers, references can refer to const:

```
int a = 1;  
const int& ra = a;  
a = 2; // ok  
ra = 3; // compile-time error
```
- The key is that **ra** is a reference to a constant therefore **ra** cannot be assigned to (same logic as for pointer)
- Note: a const reference makes no sense because a reference cannot be resealed so is by definition const !

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References to const as function arguments

- We saw that it is preferable in C++ to pass arguments by reference
- If you intend to have your function leave the argument(s) unchanged, then you need to express this intention by using the **const** keyword:

```
int my_func(const Obj& o);
```

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References to const as function arguments

- Accidentally modifying the argument will be caught by the compiler:

```
void func(Obj& o) {  
    o.speed += 50; // ok  
}
```

```
void func_2(const Obj& o) {  
    o.speed += 50; // compile-time error  
}
```

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References to const as function arguments

- Note: a function with a const reference argument can be called with either a const or a non-const argument. While a function without a const reference can be called only with a non-const argument.

```
void f1(const Obj& o) { // ... }  
void f2(Obj& o) { // ... }
```

```
int main() {  
    Obj o1;  
    const Obj o2;  
    f1(o1); // ok  
    f1(o2); // ok  
    f2(o1); // ok  
    f2(o2); // compile-time error  
}
```

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Const member function

- A member function that does not modify an object should indicate so by using the **const** keyword after its argument list.

```
class A{
public:
    int get_day() const { return day; } // const
    member function
    void set_day(int d) { day = d; } // non-const
    member function
    // ...
};
```

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Usage of const

- Programs that compile correctly (and work correctly) can be produced without using the const keyword at all
- However as a good software engineering practice, you should use the const keyword to help you track potential bugs as early as possible (at compile-time)

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Usage of const

- We saw three usages of const:
 - For object that cannot change
 - For arguments to function that should not be changed by the function
 - For (class) member functions that should not change the object

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